Boost-phase intercept (BPI) is like the weather—everybody talks about it but nobody does anything about it. Now that it has become a popular concept, there are many candidates for BPI, some of which would have advantages over the mid-course national missile defense (NMD) system currently under development. But there is a specific surface-based BPI that should be the baseline of an effective defense against ICBMs from North Korea, Iran, or Iraq, should such a defense be necessary.

Pursuit of a missile defense appears to have become a political necessity after the nine-person Rumsfeld Commission, of which I was a member, released a report in July 1998 saying that North Korea, Iran, and Iraq posed a potential ICBM threat to the United States. The report said that within five years of a decision to do so, any of those three countries could develop and deploy a few inaccurate, unreliable ICBMs, provided they had an urgent, well-financed program supported by foreign technological assistance. If armed with strategic payloads—nuclear weapons or biological warfare agents (such as anthrax)—such missiles could cause substantial damage.

The Rumsfeld Commission report was seized upon by supporters of national missile defense despite the report's explicit statement that North Korea, Iran, and Iraq already possessed short-range cruise or ballistic missiles that, if launched from ships against coastal cities, would pose an earlier, more accurate, and cheaper threat to the U.S. population. And, of course, a nuclear or biological weapon could be delivered by a ship that need go no closer than the harbor to devastate a port city—without any missile at all.

It therefore remains highly debatable as to how secure a missile defense would make the United States. Nevertheless, if domestic politics demand active defense against emerging ICBM capabilities, then national security will be least impaired if an effective system is deployed as quickly and as cheaply as possible, with the least damage to the international strategic balance and to arms control agreements.

One thing is certain: the most effective system is not one based on the current NMD architecture. Perhaps the most serious problem with a mid-course system, as many analysts have pointed out, is that it can be defeated by countermeasures that are quite simple to develop compared with an ICBM program. For example, placing the nuclear warhead in a metal-skinned balloon surrounded by dozens of similar decoy balloons would thoroughly disguise it to radar and to the seeker on the homing kill vehicle of the interceptor missile.

In fact, the inherent limitations of a mid-course system have been recognized for decades. Participants in the 1983 "Fletcher Report" on the Strategic Defense Initiative concept said that the prospect of defeating decoys in mid-course intercept was so daunting that the only potential for an effective nationwide defense lay in intercepting the target missile in its boost phase.

Intercepting an ICBM in its boost phase—that is, while the rocket motor is still burning—has other advantages over attempting a mid-course intercept. Instead of having to hit a small, relatively cool warhead that is traveling quickly, the target is a large, hot booster that is moving more slowly. BPI
also eliminates the problems of dealing with multiple warheads or submunitions.

Some analysts—such as John Deutch, Harold Brown, and John P. White—have argued that for these reasons and others boost-phase intercept should be considered in place of national missile defense. But whereas they suggest beginning with theater missile defense systems that do not yet exist and that have other priorities, I would instead jump to their recommendation that "consideration should also be given to use of the ground-based interceptor developed for NMD, in a forward theater deployment that permits boost-phase intercept." That option would be more effective and would be available sooner.

Against a potential rudimentary, but growing, ICBM threat from North Korea, Iran, and Iraq, a boost-phase system would destroy the missiles during the firing of the second or third stage of a three-stage ICBM. Instead of an interval of 20 minutes or more during which the warhead is coasting in space toward its target in the United States, a boost-phase intercept would need to be conducted within the 250-second burn time of an ICBM. But that is possible.

Not only is the engagement timeline feasible, but the construction and deployment timeline would actually be more efficient if the system were devised to be as simple as possible, without sacrificing its effectiveness. This means least reliance on existing systems that need to be modified (such as the complex multi-mission Aegis cruiser) and the willingness to develop an NMD-class interceptor from proven elements and to base it on land near the state of concern or on cargo ships converted for the single purpose of carrying these interceptors. The most effective BPI approach would be incremental, with interceptor sites deployed as the ICBM threat emerges—first against North Korea, which has by far the most advanced missile program of the three states and which provides the ideal opportunity for intercepting ICBMs in boost phase.

The Proposed System

A boost-phase intercept system that would really work would have two major components, one that has been operational for the last 30 years and another that is new in detail but not in principle or technology. The first component is the Defense Support Program (DSP), a network of satellites that has been operational since 1970 and that would easily see ICBMs launched from North Korea, Iran, or Iraq. Although initially deployed to provide strategic warning of the launch of ICBMs or submarine-launched ballistic missiles (SLBMs) by Russia and later by China, the DSP was used to provide rapid warning of extended-range Scud missiles launched by Iraq against Israel and Saudi Arabia. According to the Department of Defense, the DSP saw every ballistic missile launched during the 1991 Persian Gulf War.

The sensor on the satellite, which is at geosynchronous altitude (almost 40,000 kilometers above the Earth's surface), consists of a line of thousands of light-sensitive spots that performs a rotary sweep in just 10 seconds—somewhat like an airport radar. The sensor operates in the mid-wave infrared band, which is absorbed by water vapor in the atmosphere, so as to have the least interference from heat sources on the planet's surface. A missile launch is detected by the heat from the burning exhaust flame once the missile gets above the cloud tops. Three detections at 10-second intervals are enough to provide a very accurate track in azimuth—that is, the direction of travel of the ICBM—and there are enough DSP satellites now in orbit that the so-called states of concern could be viewed in stereo, by two satellites. This improves the timeliness by five seconds on average and provides greater reliability.

Normally, the information processed on the satellite is sent via radio downlink to a ground station and then to the North American Air Defense Command (NORAD) headquarters in Colorado Springs. There it is quickly processed, evaluated, and communicated (if valid) as warning of strategic attack—a process that takes two or three minutes. However, the DSP satellite data can be used more rapidly by having a computer system at NORAD provide the interceptor site with the requisite information (for insertion into the interceptor guidance system) on the initial point at which the seeker should expect to see the missile flame.
The interceptor site would be therefore alerted 60-70 seconds after ignition of the target ICBM—that is, some 30 seconds after the first detection by the DSP. The alert would consist of providing a "prepare to launch" signal to a couple of interceptors that would be readied for firing and the sounding of an alert so that any individuals working aboveground or on shipboard at the launch site could take cover within the next 20 seconds.

Interceptor launch would then be commanded 100 seconds after ICBM ignition, by which time the direction of travel of the ICBM would be well known, as would the position of the ICBM along that track (assuming nominal thrust for the different stages of the ICBM). These data, transferred to the interceptor just before launch, would serve to guide it toward a projected intercept point and would give the on-board interceptor seeker excellent initial pointing information.

The particular target of the ICBM would not be known at the time of interceptor launch and would indeed not be known until after ICBM burnout. For the most efficient attack on Washington, D.C., the elevation angle of the ICBM with respect to the Earth’s surface would differ slightly from that for the most efficient attack on Chicago. But it would be a small difference, and changing the target from Chicago to Washington could simply be accomplished by a longer burn time of the ICBM—the last 10 seconds of burn of a nominal ICBM with 250 seconds of burn time makes a difference of some 5,000 kilometers in the impact point. The point is that the range to the ICBM’s target does not greatly affect the trajectory during the boost phase.

The other principal element of the BPI system is the interceptor. For the first phase of incremental deployment, designed to hit a missile launched from North Korea, interceptors could be deployed at a joint U.S.-Russian site located on Russian territory south of Vladivostok or on U.S. military cargo ships stationed in the Japan Basin, hundreds of kilometers from North Korea. (Against ICBMs that might eventually be developed by Iraq, a single interceptor base in southeast Turkey would suffice to protect the entire U.S. national territory. Iran, a much bigger country, would require interceptors based in the Caspian Sea, or perhaps in Tajikistan and on ships in the Gulf of Oman.)

Interceptors launched from either point 100 seconds after ICBM ignition on the basis of DSP detection forwarded directly to the interceptor site would have the nominal intercept point loaded before launch and would initially fly a pre-programmed trajectory to take them toward that point. However, the burn time of the BPI interceptor, using three stages of commercially available rocket motors (as with the NMD system), should be some 100 seconds, and the ultimate velocity would be about 7 kilometers per second—just about ICBM speed. An interceptor burn time of 100 seconds allows plenty of time to intercept ICBMs launched from even the most remote part of North Korea. In fact, the interceptor would not even need to reach maximum speed.

The interceptor should be self-guided so that after it clears the dense atmosphere, its seeker would look out and view the missile flame against the darkness of space. Since the flame is readily seen by the DSP from a distance of 40,000 kilometers against the relatively warm atmosphere of the Earth, it would be no problem for the interceptor to see the missile flame from a distance of 1,000 kilometers or less against the coldness of space. (Indeed, the flame would appear about 1,600 times as bright to the seeker as it does to the DSP.)

The interceptor would then guide itself toward a collision with the rocket flame until it reached a position at which it would need to shift its aim from the brightest part of the flame to the leading edge and then find the “hard body” of the missile immersed in that flame.

The seeker that views the flame would not be a cooled infrared detector as used in the NMD interceptor, or even an uncooled mid-wave infrared detector as used in the DSP. A better signal would be obtained by using a visible or near-ultraviolet detector, which requires no cooling system, for the general seeker during most of the interceptor’s trajectory. To actually see the missile hard body within the hot and bright flame requires a seeker that could detect the heat from the missile itself: a "thermal infrared" detector. However, the thermal infrared detector needs only a limited field of view because the missile is known to be close to the leading edge of the rocket flame, so the infrared seeker is unlikely to require cooling and needs relatively few detector elements.
The kill vehicle's seeker is fairly standard—much poorer sensitivity and resolution suffice than is the case for the NMD seeker. The BPI seeker does, however, have a unique requirement of having to operate during the interceptor boost and staging, when accelerations reach up to 40 times the force of gravity as the interceptor burns out at an altitude of about 170 kilometers. This means that the seeker should be supported at its center of mass or in conventional gimbals, as is the case with some elements of guidance systems on SLBMs. The interceptor can thus look out in the desired direction, largely decoupled from the accelerations of the interceptor. This simply requires a repackaging of available components, and its feasibility and initial development should be assured by letting contracts for a few months to small firms whose only commitment is to perform this task.

The target ICBM is much larger than the nominal re-entry vehicle that has been the target of several successful mid-course intercepts in the U.S. theater and national missile defense programs, and it is much more fragile in boost phase than a re-entry vehicle that is built to withstand brutal slowdown in the atmosphere. Since the collision speed of the interceptor with the missile exceeds 10 kilometers per second, the energy communicated in such a collision by the 100 pounds or so of interceptor seeker and structure is equivalent to the detonation of about 1,000 pounds of high explosive. Contact anywhere on the thrusting ICBM would destroy the rocket and not only knock the warhead off course but probably also destroy it.

The Proposed System vs. Others

As mentioned earlier, a boost-phase intercept system would have a much easier time finding its target, and it would not be vulnerable to the countermeasures that defeat mid-course intercept. But as a system deployed incrementally against the threat (i.e., first against North Korea), using only existing satellites and a new interceptor and base, the proposed BPI approach will also be much cheaper than the mid-course NMD. It will not require modifications to the existing early-warning radars or the deployment of the advanced X-band radars that the NMD system requires.

Furthermore, the technology is either already in place—as with the DSP—or is less complex than the technology currently being developed for NMD. The relative simplicity of the BPI seeker and the fact that it requires no cooling gives it a substantial advantage over the NMD system, which reportedly failed in its January test because of a coolant problem. Of course, using other NMD components is simple but not necessarily easy, given that the NMD booster has recently been revealed to be more than a year behind schedule and that the last two intercept tests have failed. But consensus is that this is less of a technical problem than a management one.

Speed is another reason that the BPI proposed here is preferable not only to the national missile defense being developed, but also to other boost-phase proposals based on existing theater missile defense programs. Mentioned in the news recently are BPI as an adjunct in a "layered defense" based on the current NMD; sea-based BPI as an outgrowth of a "sea-based NMD," which itself would be an outgrowth of the Navy Theater Wide system; some kind of BPI as an evolution of the Theater High Altitude Air Defense system (THAAD); and, finally, the Airborne Laser, under development by the Air Force for "theater missile defense," even though it would be more effective against ICBMs with their longer burn time and higher altitude of burnout.

It would be foolish to tie a BPI system against a supposedly urgent threat to evolutions of TMD systems like Navy Theater Wide and THAAD, which are not scheduled to be operational until 2008 or 2009. Furthermore, neither Navy Theater Wide nor THAAD are designed to be boost-phase systems. THAAD is designed to intercept a warhead in its descent phase, not a rocket in its boost phase. Navy Theater Wide is designed to effect ascent-phase, mid-course, and descent-phase warheads—in other words, anytime after rocket motor burnout at the end of the boost phase. The Airborne Laser is unproven in concept and staggering in cost because it would require the continuous presence of large 747-class aircraft within perhaps 200 kilometers of the launch site. The protection of those aircraft against conventional air defenses is something that cannot be assured since, for the most part, they would be operating over the air space of the opponent.
One of the primary advantages of a BPI system is its limited capability. The system would have zero effectiveness against ICBM launches from Russia or China since their launch sites are out of range of interceptors based either on land or at sea. Russian President Vladimir Putin has explicitly offered to discuss cooperative boost-phase intercept with the United States, specifically in the case of North Korea, although neither he nor his representatives seems to have gone beyond that simple proposition. Nevertheless, such a statement (sometimes couched with the proviso "using TMD assets") shows a readiness on the part of Russia to work with the United States in using BPI to counter the emerging ICBM threat, without destroying the 1972 ABM Treaty.

Indeed, the treaty bans a defense of "the national territory" by intercept of strategic missiles "in flight trajectory." But it is recognized by all parties that the ABM Treaty was written to limit defense of the Soviet Union against U.S. strategic missiles and of the United States against Soviet strategic missiles. It was not intended to limit defense against missiles from North Korea, Iran, or Iraq. If agreed by the two sides, the ABM Treaty could be modified by the addition of a protocol, which might read:

Recognizing the intent of the ABM Treaty of 1972 to limit the defense of the national territory of each Party against the strategic ballistic missile forces of the other Party, the Parties hereby accept the deployment of a specific system for protection against ballistic missiles of certain other states, as follows:

1. Interceptors deployed at sites on the territory of any Party to the Treaty, operated jointly (by Russia and the United States);

2. Interceptors (give specifics of proposed NMD interceptor airframe) equipped only with uncooled seekers and deployed on ships without ABM radars, operating in the Japan Basin, the Gulf of Oman, or the Caspian Sea;

3. Other systems that may from time to time be specifically agreed by the Parties.

Boost-phase intercept therefore makes a great deal of strategic sense as well. Because it would not present a threat to the Russian or Chinese nuclear deterrents, BPI would not upset the international strategic balance and therefore would have a far smaller impact on the future of arms control than NMD would.

However, BPI does face some challenges. It is sometimes argued that such a system might shoot down an innocent satellite launched from North Korea, Iran, or Iraq. It would seem that a nation that knew of the existence of such a system and wanted to launch a satellite would not do so in a direction that would carry it over the United States or Canada; a country wanting to do so, for some reason, would announce what it was doing and provide some transparency to ensure that the launch was not perceived as a strategic attack. At worst, the United States would destroy a satellite launch and pay for it.

Another potential criticism is that the ships in the Japan Basin housing the interceptors are in principle vulnerable to attack from a North Korean ship or submarine, despite their being hundreds of kilometers from North Korea. This vulnerability is mitigated by the fact that there would be at least two ships—simultaneous attack on both of them is not a simple matter and would beg a pre-emptive strike. Furthermore, the proposed joint interceptor site on Russian territory south of Vladivostok would not be vulnerable in the same way. The same can be said for the ships and sites positioned to intercept ICBM launches from Iran or Iraq. Incidentally, the proposed mid-course NMD system is also vulnerable in this way to the extent that it depends on the performance of the X-band radar to be built on the Aleutian island of Shemya.

**Conclusion**
It should not be imagined that a boost-phase defense against the emerging missile powers would receive unanimous support. Some supporters of missile defense are looking to deploy a far more robust system that has broader capabilities. For instance, in February 7 testimony to the Senate Foreign Relations Committee, James Woolsey, another Rumsfeld commissioner, was asked by Senator Joseph Biden (D-DE) whether he would support a defensive system that worked perfectly against North Korea, Iran, and Iraq but had no effectiveness against China or Russia. Woolsey said that he would not and that he favored a space-based system of interceptors that would have some capability against these two countries.

If the United States decides that it must deploy a missile defense to counter the growing ICBM threat from so-called states of concern, then the boost-phase intercept system described here is likely to be the quickest, cheapest, and most effective option available. The fact that BPI could be acceptable to the Russians and the Chinese and could be accomplished with relatively minor changes to the ABM Treaty is a major benefit that could also win NATO support.

Boost-phase intercept should be given serious consideration against what is potentially a serious threat. But the more urgent and more serious threats to the United States from these same countries—for instance, short-range missiles launched from ships—should be given greater priority. National security is not served by focusing on an easily defeated defense against an ICBM threat that is more difficult to develop than these short-range threats. A serious program of boost-phase intercept of ICBMs from North Korea, incrementally deployed against Iran and Iraq if those threats should emerge, would be a more appropriate and more effective line of defense.

NOTES

1. Some of the ideas in this article were first put forth in a presentation given at the Department of State. See Richard L. Garwin, "Cooperative Ballistic Missile Defense," Secretary's Open Forum on National Missile Defense Against Biological and Nuclear Weapons, November 17, 1999. (www.fas.org/rlg/991117.htm)

2. Delivered to a typical U.S. city, which has 3,000 people per square kilometer, a payload of 100 bomblets, each containing two kilograms of anthrax slurry, could be expected to kill some 100,000 people—compared with about 60,000 for a first-generation nuclear weapon, such as those used on Hiroshima and Nagasaki.


5. The burn time of a first-generation, liquid-fueled ICBM could actually be longer.


Richard L. Garwin is Senior Fellow for Science and Technology at the Council on Foreign Relations.
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